MyState: Sharing Social and Contextual Information through Touch Interactions with Tagged Objects

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ABSTRACT
Sharing social and contextual information via services like Facebook, Twitter or Foursquare has become extremely popular in the recent years. This paper introduces the novel MyState concept in which users can augment any kind of object with Near Field Communication (NFC) tags, can write any social or contextual information on those tags using their mobile phones and can publish this information on a social networking site just by touching such a tag with their phone. The distinct features of MyState are A) the possibility to augment any personal or public object with any contextual or social information, B) the possibility that everybody can touch those tags in order to post the related information to a social networking site, C) the speed and convenience to publish information by a simple touch as users don't have to look at the mobile phone screen, interact with mobile phone menus or write any text when touching an already deployed tag. The paper reports on two field studies which provide insights on where the participants placed the tags, how they used MyState and what type of information was shared. Here we observed that users typically shared identity, location, activity and time, but also feelings, social meanings and experiences. Furthermore we identified several distinct social usage patterns such as synchronizing activities, expressing moods, games and tracking shared items.

Author Keywords: NFC, context, social, touch.

ACM Classification: H5.2 [Information interfaces and presentation]: User Interfaces. - Graphical user interfaces.

INTRODUCTION
Social network sites, such as Facebook or Twitter, allow users to create a presence in a social network, connect with others, and communicate with them directly or indirectly. Beyond the initiation and maintenance of social relations, the instant and direct communication with others through lively personal messages is a key feature of such systems. In particular, Facebook has attained huge popularity from its inception in 2004 with over 500 million users worldwide to date [18].

Aside from the trend towards multimedia-type messaging in these sites, we are also currently seeing *real-time* and *contextual* messaging within social networking sites. The former was set by Twitter, which was followed by the "live feed" from Facebook. With respect to context-based services, location-based social networking such as Foursquare, Gowalla or Facebook allows users to check into places they are visiting in order to let their friends know where they are.

With MyState [7], we enhance this experience by letting users easily and explicitly publish real-time and contextual information by linking the virtual world to the physical environment using Near Field Communication (NFC) technology. NFC enabled mobile phones can write information onto NFC tags and can read information from them when they are touched. NFC tags, which are basically conventional passive RFID tags, can be attached to physical objects and store information about the object (see Figure 1 (a)). Information can be input via an NFC phone (see Figure 1(b)) and written to the NFC tag by touching the phone and tag (see Figure 1 (c)). Consequent touches will result in the phone reading the contents of the tag and automatic posting of the information read from the tag to the MyState Facebook application (see Figure 1 (d)). Moreover, these touches are not constrained to the user who wrote the tag: any MyState user can use this tag for posting its message. We use Facebook as one particular example of using MyState to connect the virtual world primarily due to its social aspect and its popularity with a broad user base.

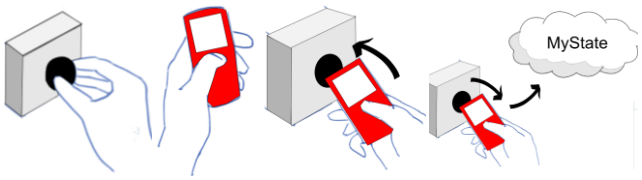

Figure 1. (1) Attaching a tag to an object (2) typing message on the phone (3) writing message via NFC onto a tag (4) any users can then read a message via NFC from the tag in order to post it to the MyState Facebook application.

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By attaching the NFC tags to physical objects, the user is required to be near these objects. If this is not the case, users can still use the traditional method of sending messages, for example, via Facebook on their phone. This work is thus not focused on replacing traditional approaches; it is a quick method of sending reoccurring messages when convenient. A write-little/read-often greatly reduces the impact of the deployment time as reading the tags only takes a couple of seconds. We also utilize the *always on* nature of mobile phones so users do not have to wait for the device to start up.

Through MyState, we also explore the personal significance – or shared significance – of objects. Associated to physical objects are meanings; the tangibility of which may be resident in the object itself. Such utilitarian objects will likely have action-based information attached about the task the user is currently using the object to complete. These actions may also lie not only in the utility they provide, but in the emotional response they provoke from the user and/or others. The meaning may also stem from symbolic interpretation of an object or cultural interpretation from, for example, marketing, or more personal, shared meanings from historical experiences or associations to friends and family (e.g. gifts and photographs). Another association between personal objects and their owners is the identity they provide to promote individualization or their shared commonality with a particular group. The purpose of MyState is to further describe these meanings and enable users to conveniently publish these meanings to an audience. To achieve this, it is important that there is a physical attachment between the MyState descriptions and the physical object.

This work has two main contributions. The first is the MyState concept that exploits the direct, explicit and physical interaction with NFC-tagged objects to facilitate sharing of information with a social networking service. The second is a first-time insight – through two user studies – into how the users personalize this type of system to suit their needs and the connection they have with tagged objects. This is made possible through the fact that we focus on the user as responsible for deploying the NFC tags.

In the next section of the paper, we provide an overview of the related work. Following is a section that explains how MyState is used. This leads onto a more technical description of the prototype. We then move onto the study section and discuss the most salient findings. The paper closes with a summarizing conclusion.

RELATED WORK

We will begin with work related to context-awareness and a definition of context from [2]: "*context is any information that can be used to characterize the situation of an entity. An entity is a person, place, or object that is considered relevant to the interaction between a user and an application, including the user and applications themselves*." The most important forms of contextual information are considered to be location, identity, activity and time.

Pertaining to context-awareness using mobile phones, work by Siewiorek et al. [17] use a variety of sensors to gather information about the user's context and uses this information to reduce the cognitive load for various applications on the phone. SurroundSense by Azizyan et al. [4] enables greater accuracy of localization than GPS alone by using the phone to sense sound, colour and light in order to provide greater context about the location. Other work where mobile phones sense context is the Context Watcher [11]. Here, a wealth of contextual information, such as mood and experiences, can be collected and shared online with others by using various social networking sites.

The issue with these aforementioned context-awareness approaches is that the user has little or no control over when the context is gathered and posted. Ensuring users have control over their privacy is paramount. This is especially true for location-based information. There may also be issues concerning the accuracy of this information based on the ability of a device's sensors, for example, GPS accuracy.

We focus on a particular type of context awareness that is categorized by Dey and Abowd [2] with the concept of tagging conceptual information for later retrieval. Kindberg et al. [9] attach URLs to things, places and people using infrared beacons in order to give them web presence. In addition, contextual information, such as location, identity and interests, is also focused on. However, here it is assumed these beacons are pre-attached and do not require attachment by the end-user.

With MyState, we demonstrate the usage of the prototype to not only share identity, location, activity and time, but also user feelings, social meanings and experiences through our corresponding user studies. What's more, the advantage of this approach is that it provides the user with complete control over the information posted. This aspect of user control is intrinsically linked to privacy, and using NFC, we provide control with low effort, quick and explicit touch interaction.

Want et al. were among the first who augmented objects such as books, documents or business cards for mobile interaction with passive RFID tags [21]. NFC is a short-range RFID (Radio Frequency Identification) technology suitable for touch-based interaction between NFC phones and NFC tags. Powerless NFC tags can be read by NFC-equipped phones and are capable of storing a few kilobytes of data. First commercial NFC devices and prototypes are available since circa 2005 and corresponding services, applications, interaction techniques, usage scenarios, interaction techniques and social aspects have been the focus of numerous publications, research projects and commercial trials.

Integrating RFID technology into mobile phones has already achieved huge popularity in Japan and its momentum is driven mainly by payment and ticketing [5], but it has also opened opportunities for accessing information from smart objects. NFC is getting momentum all around the world, with the largest mobile phone vendors already shipping (e.g. Google Nexus S or Nokia C7), committing to bring models in the next years [1], or showing high interest (e.g. NFC-related patents by Apple [3]).

As with our approach, there is existing work that compounds NFC technology with both social and contextual information [6, 10]. However, with these works, it is assumed that tags are pre-deployed in the environment. In contrast, we focus on the user deploying tags. Furthermore, MyState users are able to maintain the data on tags by changing tagged data when necessary.

An NFC example where users were responsible for tagging objects is the work by Jalkanen [8] which allows users to write data to NFC tags in the form of SMSs. Once a tag is read, the phone sends the message to a recipient. However, this feature does not connect to a social network where groups of observers can easily view posts in a central place. Touchatag (touchatag.com) is a similar service that allows end users to tag real world objects and to use predefined apps (e.g. to open a webpage or to initiate a Skype call) to define the action that is triggered when touching a tag. A step in the direction of using NFC for social purposes is Google Hotpot [19] which uses NFC tags for shop recommendation systems. Shop owners can place such tags in their shop window themselves. The uses of these tags are limited, however, as their content cannot be changed and only points to the shop's place page on Google maps.

There are also examples in 2D barcode technology, such as Active Print (activeprint.org) and Semapedia (semapedia.org), which focus on the user as responsible for tagging objects. These allow the user to print out their own visual codes so they can attach them to objects. The codes then translate to resources on the internet. However, a comparison of interaction between NFC and visual markers by Reischach et al. [16] showed that NFC was both faster and easier to read based on a product identification study. Similarly, a study by Mäkelä et al. [13] presented significantly greater preference results for NFC over 2D barcodes based on speed, effort and intuitiveness. The underlying reason is that the mobile interaction with barcodes involves opening a corresponding camera application and focusing the view finder on the tag to show the complete barcode in a sufficient resolution. This requires obviously a higher cognitive effort and task completion time when compared with just touching a NFC tag with a mobile phone.

MYSTATE: DISTRIBUTION, DEPLOYMENT AND USAGE

There are three main parts to the MyState prototype: a phone (equipped with an NFC reader and the MyState phone application), the NFC tags, and the MyState Facebook application. We will refer to the NFC tags as *MyState tags* from here on as they are used within the context of the MyState prototype. The phone is used to read and write any textual message to the MyState tags. These are then placed in meaningful locations. The MyState tag can also be labelled if its purpose is not apparently clear from the object it is attached to. Subsequent touches between the tag and phone will send the message as a MyState post to the MyState Facebook application. In a collaborative context, tags could be rewritten by a number of different users if the object (or its meaning) changes in order to keep the tags up-to-date. In addition, many users can share a tag; thus, allowing users to take advantage of tags in the environment without even having to deploy them. Of course, they will get a preview before sending any data. It is also conceivable that the content of a tag is user specific.

Distribution

A distribution scenario for MyState would involve two processes: a software distribution for the Facebook application and the corresponding phone application, as well as a hardware distribution for the MyState tags. The Facebook application could be distributed as a verified application on Facebook. The mobile application could be distributed via a mobile application store. Alternately, when the Facebook application is installed, it could supply a download link for the mobile application. In either case, a postal address should be supplied to allow the distribution of a large number of MyState tags via the postal service.

Deployment and Usage

Using a simple example, we will now explain three main procedures: placing the tags in the environment, writing to the tags, and reading the tags in order to send a post. In Figure 2 (left), a tag has been labelled "In my office" and attached on an office door at the user's workplace.

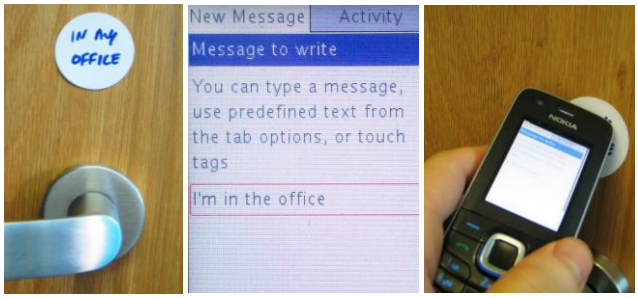

Figure 2. MyState tag deployment: tag placement (left), inputting a post, (centre) and writing the post to the tag (right).

Using the phone's keypad, the MyState post "I'm in the office" is input using the phone keypad (see Figure 2 centre). Once the post is input, the user then touches the tag in order to write this information to the tag (see Figure 2 right). The phone vibrates and provides visual feedback to indicate the tag is being written to.

All subsequent reads from the tag (see Figure 3) will send the post to Facebook. In fact, any user sharing this office can touch the tag and post the corresponding message. It will be delivered to this person's account. The mobile ap-

plication starts automatically on the mobile phone (using the NFC Push Registry) and sends the message after which the mobile application closes automatically. Although this takes some time, it does not require the user's attention.

Figure 3. Touching the MyState tag with the phone to post.

The post can then be viewed on the MyState Facebook application wall (see Figure 4 left). This wall is similar to the Facebook wall but tailored to short social and contextual messages formed from the information trails left by users. We considered this wall necessary for two reasons. Firstly, posts on daily routine are likely to have high repetition and could flood the Facebook walls. Secondly, posts may only be relevant to smaller groups. This is especially true when they relate to your daily state; for example, sharing posts about when you are awake or at work.

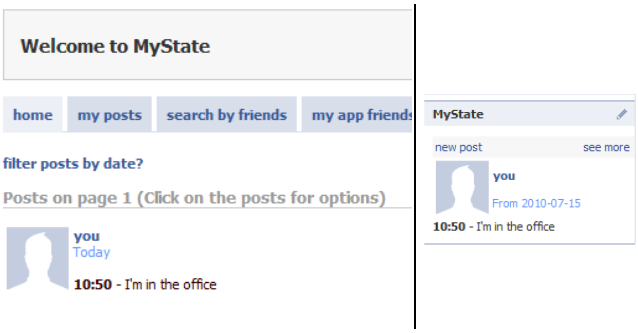

Figure 4. The MyState Facebook application wall (left) and the MyState profile box (right).

As with the Facebook wall, the MyState Facebook application wall merges all the MyState user posts who are currently Facebook friends. Again, in keeping with the Facebook wall, posts can be selected for removal or to add further comments. Returning to the usage example, a MyState friend may wish to visit several MyState users from a nearby building. Using the search tool in MyState, they can check the latest state of their friends and avoid a wasted trip or several phone calls. We also ensure that non-MyState users can view recent MyState posts using an expandable profile box located on a user's Facebook profile page (see Figure 4 right). This was a useful feature for the studies (discussed later in the paper) as participants could make the posts meaningful to those outside of the study who did not have access to an NFC phone.

If the user needs to use the tag for another purpose, they can simply peel the tag off the door, place it onto another object, attach a new label, and replace the message data on the tag with another tag write.

TECHNICAL DESCRIPTION

The MyState architecture is shown in Figure 5. There are two ways in which users can interact with the MyState server. The first approach involves logging into Facebook and loading the MyState Facebook application wall via a laptop or desktop computer. In order to load the wall, Facebook requests Facebook Mark-up Language content from the MyState server. On this request, the server makes calls to the Facebook API to get resources such as the user's current session and friends. Via the MyState wall, posts can be viewed, queried, added, removed, and commented on.

The second approach involves communicating with Facebook using the NFC phone. When the data is read from a tag and posted, the phone bypasses the Facebook web site and communicates directly with the MyState server. In order to achieve this without forcing the user to log into Facebook, the MyState Facebook application requests that users allow offline access when installed. This provides an infinite session key which is stored in a database and used to create Facebook user sessions each time posts are sent from the phone. Thus, the user only has to log into Facebook once.

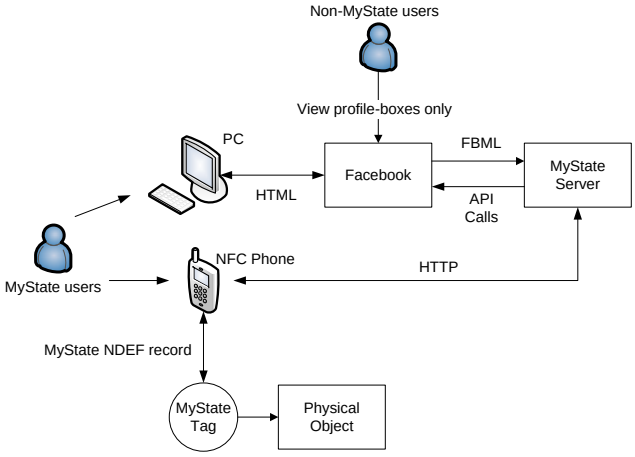

Figure 5. The MyState architecture (primarily consisting of the MyState tags, the NFC phone, and the MyState Server).

The next stage is to connect the phone client to a corresponding Facebook account. To prevent the possibility of users masquerading as others (particularly if Facebook wall posts were sent), a desired requirement was that the user's login credentials would not be stored anywhere in the architecture. Therefore, when a user installs the MyState Facebook application, a one-way code is generated corresponding to the user's Facebook account. This is then displayed on the MyState wall and must be input into the phone client in order to register the phone. Once input, the code is encrypted and sent from the phone to MyState server for validation. After registering, the code can be hidden from the wall.

The NFC Tags

Assuming the tags have not been pre-deployed (e.g. when a new office building has been completed), the creation of MyState tags is carried out by MyState users themselves. MyState tags are NFC tags (currently 1k Mifare with a diameter of 42mm) that store one or more MyState NFC Data Exchange Format (NDEF) records. This record is responsible for storing arbitrary textual posts written by the user and is stored in a WAP Binary XML (WBXML) format, which achieves around 50% compression with little computational overhead. The phone application was developed in Java ME with JSR 257 for NFC capability and was tested on the Nokia 6212 NFC phone.

The physical form of a MyState tag involves the NFC tag sandwiched between two peel-able white labels. One label is attached to the front of the tag to allow hand-written/drawn labels to be replaced easily. The other label is attached to the rear of the tag as the tags have permanent adhesive which could damage objects. In between these layers, spacers could be used to isolate the tag from metal inference if necessary. Posts are stored as elements in an XML file. Multiple elements could be written to a tag as in Figure 6. What's more, multiple tags could be read to add a number of elements to a MyState post.

```
<Post>
        <Element prefix="I'm">on my way back</Element >
        <Element prefix="I'm"> tired</Element >
</Post>
```

Figure 6. Post XML format on the MyState tag.

For example, "I'm on my way back from work and I'm tired" can be sent from a single tag that contains two post elements. However, an additional element could be added to the MyState post, e.g. "I'm hungry", by touching another tag. Once all the elements have been input, they can either be written to a tag to be formed on the next read, or formed immediately into a post and sent directly. In the previous example, the following post would be formed: "I'm on my way back from work, I'm tired and I'm hungry".

TESTING MYSTATE IN THE FIELD

We carried out two studies (one after another), each targeted at a different group of participants. The first study – Study A – was targeted at a group of Master's students studying the same course at the same university and with fairly detached social bonds to one another. This study helped to examine what uses MyState had in relation to creating social bonds through learning more about one another. In contrast, the second group consisted of flat mates who had existing strong social bonds. The housemates were also studying at the same university, but at undergraduate level. This study – Study B – was focused on the existing bonds between the users and how they use MyState to communicate feelings to one another and synchronize their social activities. Both studies followed the same procedure, though the implementations differed in that the implementation for Study A had no feature to change a post once it had been read from a tag. The feedback from Study A led to its integration into the Study B implementation.

The Study Procedure

Both studies took place over at least two weeks (15 days for Study A and 20 days for Study B). There were 5 participants in Study A (mean age of 28.6, 4 males and 1 female) and 8 for Study B (mean age of 18.5, 5 males and 3 females). All participants in the studies had used Facebook in the past and had a high comfort level with mobile phones. Each study began with a meeting with the participants to explain MyState and the study procedure. Participants then added one another as their Facebook friends and each installed the MyState Facebook application. We then provided them with the hardware (see Figure 7) consisting of Nokia 6212 phones, 300 MyState tags and 600 blank labels. Four out of the five participants in Study A used the NFC phones as their personal phone. This is also true for seven out of the eight participants in Study B. We paid the four respectively seven users a mobile data flat rate for the duration of the study so they were able to use their own SIM during the study. A SIM card with a mobile data flat rate was given to one user of study A and one in study B as their existing contracts didn't support such data flat rates.

Figure 7. NFC phones, MyState tags and labels for the study.

Three prizes were given to the users who displayed the best combination of usage and creativity, though the participants in Study B were told that after the half-way stage in the study, they did not receive an incentive for the second half. This would give an indication of whether MyState would be used outside of the study yet the period of incentives would encourage tags to be initially deployed.

We also used the MyState Facebook application for logging as it also stores actions (e.g. writing to / reading from a tag, sending without touching a tag), and corresponding times and dates. Additionally, a diary study page was provided on the MyState Facebook application where participants could view a log of previously written tags or sent posts.

Whenever participants wrote a post to a tag, the phone would remotely update the log as a background event. The log was used as a reference for the participants who could then provide more information about these events, for example, Figure 8 shows the questions asked about the post "I am presenting". These elicited the purpose of the post, reasons for sending via NFC, and any other relevant further comments. Questions relating to specific tags written uncovered aspects such as what the object the tag was attached to and where the object was.

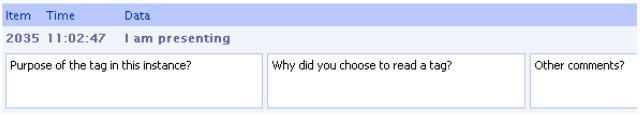

Figure 8. Study questions about a particular MyState post.

Specific to Study B were various surveys. We investigated the participants' attitude towards the prototype at different stages of use (before they used the prototype, after the first half of the study, and at the end of the study). As an indication of their overall attitude, we elicited their perceived ease-of-use and their perceived usefulness of MyState in accordance with the Technology Acceptance Model (TAM) [20]. Additionally, we collected usability ratings from the Computer Usability Satisfaction Questionnaire (CUSQ) [12] at the mid-point in the study and the end of the study. We also elicited workload ratings at the end of the study using the NASA Task Load Index (TLX) survey [14]. Finally, at the end of the study we performed one-on-one interviews for more general feedback.

The Results of Both Studies

We will begin by examining if the users actually used MyState. Based on prolonged usage, we can then investigate how they used it. Though it is ideal to have prolonged usage throughout the study, we are really interested in "how is it used?" rather than the question "how much is it used?" There are several reasons for this. Firstly, there is a critical mass of MyState users required for it to be used effectively. We increased the audience by using the MyState profile boxes as they can also be seen by non-MyState users (albeit only passively as they do not have the NFC phones). Secondly, the frequency of posts depends entirely on the type of users, their routine and their experiences. And thirdly, there are inherent complications with the experiment, such as some users preferring to use their own phone over the NFC phone and lack of tagged objects outside their environment. This was especially apparent during the weekends when participants travelled home. In doing so, they left most of their tags behind, had fewer reasons to post one another, and fell out of their routine. However, this is only a problem due to the constrained study environment. Outside the study, one may expect to find tags also at participants' homes and in public areas.

We classify three types of actions in this section. *NFC writes* are the number of MyState tags written to. *Non-NFC posts* are the posts sent by the phone without using NFC (i.e. direct typing on the phone). It should be made clear that the users were provided with a non-NFC based alternative which allows messages to be posted in the same manner as the Facebook mobile applications; the participants were encouraged to do so if they wished to use this approach. Finally, *NFC posts* are sent via a MyState tag read (allowing for a modification of the post between reading and posting).

An informal test shows that writing and sending the message "I'm in work" took 16 seconds with the *Non-NFC approach* using multi-tap text input. At the same pace, writing the message to a tag and attaching it to an object it took 29 seconds. This, combined with a NFC read time of 2.5 seconds, results in a total of 31.5 seconds. Here, we see that sending directly needs about half the time of the combined NFC approach. In order to be effective, it must (1) provide much lower times during use and (2) there needs to be a high level of tag resuse. We see that the NFC read time of 2.5s is very much a reduction of the 16s required to send the message without NFC.

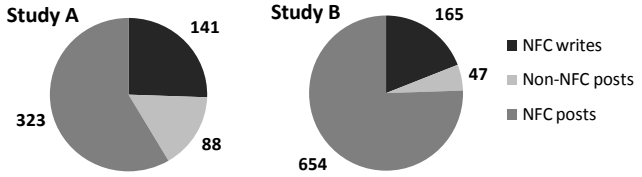

Figure 9. Proportions of the 3 main interactions: (left) for Study A (right) for Study B.

From Figure 9, it can be seen that during the two weeks of Study A, users had 141 NFC writes, 88 Non-NFC posts, and 323 NFC posts. For Study B, participants had written slightly more tags (165) and almost double the number of NFC posts at 654. The ratio of reads to writes is very important as it shows the overall effort required in relation to simply typing a message on the phone. With Study B, we see that the ratio of reads to writes is 4:1, repectively. Returning to the informal times gathered before and using this empirically determined ratio of 4:1, the Non-NFC approach would take 64s, the combined NFC approach would take 39s and (around 40% quicker). Thus, even a ratio of 2:1 would make the MyState deployment worthwhile. In addition, the number of reads will only increase with time, and in this example, the message is quite short putting more emphasis on the time to deploy a the tag. The noticable difference in read-to-write ratio between the studies is based on three effects.

Firstly, it is not surprising that the ratio between reads and writes seems to increase over time (15 days for Study A vs. 20 days for Study B) due to a write-little/read-often principle. Secondly, there was a higher level of sharing in Study B due to the fact that the participants lived together. As an example, two tags were used to indicate when users had left and arrived at the shared accommodation; these were then used by all users. A third reason for the greater proportion of reads in Study B is that Study A participants were unable to personalize their messages after they had read a tag. Consequently, they relied on *Non-NFC posts* as a suitable alternative. By supporting this feature in Study B, we significantly increased the proportion of reads.

The mean number of MyState interactions (NFC writes, Non-NFC posts and NFC posts) per participant in Study A was 72 (*SD* = 45.2). The study furthermore showed sustained usage as the mean number of MyState interactions

per participant in the last 3 working days was 6.1 (*SD* = 2.5) although usage declined when comparing it with the first 3 working days of the study (*M* = 8.9, *SD* = 4.5). In Study B, we observed that usage declined over time but were again able to see sustained usage although we stopped rewarding the combination of usage and creativity after day 13 of 20. The mean number of NFC posts per participants was 8.3 (*SD* = 2.3) for the first three working days and 1.4 (*SD* = 0.3) for the last three working days of the study. The reasons being in particular the lack of a critical mass of MyState users and the used Nokia 6212 phone (the only commercially available NFC phone at that time in *country anonymized for blind review*).

Regarding the survey from Study B, we find positive results across all items. When focusing on participants' attitude towards the prototype using the TAM survey questions, on a 7-point scale (1: strongly disagree – 7: strongly agree), participants' mean rating of whether they perceived MyState as useful was 4.2 before use, 4.4 during use, and 4.5 after use. On the same scale, they also rated ease-of-use as 5.8 before use, 6.0 during use, and 6.2 after use. With respect to both perceived usefulness and ease-of-use, we thus see rating improvements over time.

We also found positive ratings for every question asked from the CUSQ surveys regarding usability. On the same 7-point scale (1: strongly disagree – 7: strongly agree), the mean rating was 5.3 with all questions over a rating of 4; in particular, learnability yielded the highest ranking for MyState with a rating of 6.4.

Finally, the workload ratings from the NASA TLX survey show overall workloads of 20.3 for sending NFC posts, 28.6 for sending non-NFC posts via the phone, and 21.9 for sending posts via the MyState Facebook application. Figure 10 shows greater details on the workload ratings, in particular, the *effort* adjusted ratings for sending a non-NFC post via the phone (131.7) was over twice that of NFC posts (52.4) and posting via the MyState Facebook application via a laptop or PC (58.7). Another substantial difference was with the *mental* workload adjusted ratings. They were much less with the NFC approach (39.7) than non-NFC posting with the phone (80.9) and posting via a laptop/desktop (63.5). Wilcoxon signed-rank tests showed that the both, the effort ($Z = 2.20$, $p < .05$) and the mental load ($Z = 2.23$, $p < .05$) with the NFC approach is significantly lower than manually inputting and sending a message on the phone.

Where did they place the tags?

With respect to the objects onto which the tags were placed, they varied in mobility and ownership. There were objects, such as those in Figure 11, which people would take with them during the day. For example, tags were placed in wallets and the phone could read the tag through the wallet in order to indicate that the user is shopping. These mobile objects could be read to identify the user or for commonly sent messages such as "I've finished" to add closure to a variety of activities with a single touch. Also, these objects are mostly owned by the users themselves. On reflection, many of these hand-held and wearable objects may benefit from a different tag form-factor; thus, tag fobs could be supplied for such situations.

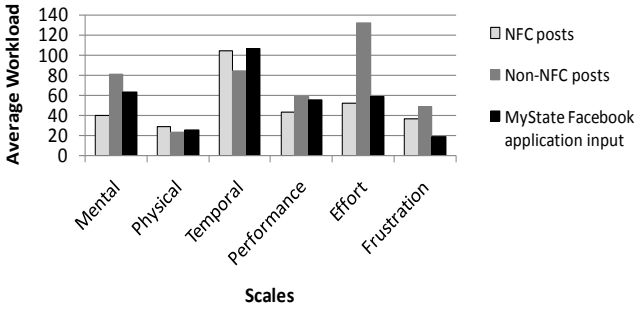

Figure 10. NASA TLX survey results for the three different post methods.

We also saw less-mobile objects being tagged around the home or car. These were a mixture of owned and shared objects which typically relate to a range of activities around the home (see Figure 12) or destinations with the car. When the objects are shared, they were typically tagged to synchronize their corresponding sharing activities accordingly. In such situations, an addition to the application could be a feature for searching the last known location or user of the object given the search criteria of the object. Also, the application could benefit from a calendar view to display multiple user activities in an organized manner.

Figure 11. Mobile objects tag by participants.

Figure 12. Tagged objects in the home.

There were a few occurrences when the users would tag public places (see Figure 13, left). This low occurrence is a result of a lack of MyState users in the public environment. Still, it is interesting to see that these public areas are tagged as users may spend sufficient time there. Also, on exploring the spatial configuration of the tags, we learn that some surfaces would be used to form a multi-tagged interface whereby multiple MyState tags are mapped to a single

object (see Figure 13, right). Users are then able to read from multiple tasks for a combined post, for example, "I'm busy and watching TV." When considering future forms of tags, providing tags with different colours or shapes could help to logically group these options when there is insufficient space to group them spatially.

Figure 13. (Left) MyState tag attached to public bench (right) multi-tagged interfaces.

How did they use MyState?

Practical Usage

A primary use of MyState was for the participants to publish their location. Due to the fact that there are no constraints on the accuracy of the localization (c.f. GPS), the levels of location granularity ranged from, for example, a presence outside of the university, to a specific room. In accordance to routine, participants tended to have a high level of repetition in their locations (e.g. town, home, work, particular rooms at home or work, etc.) This resulted in a high level of reuse for the MyState tags when it comes to publishing user locations. For example, the message posted when users left the flat was "Has left the ash house", which was written once and posted 77 times via MyState tag reads. By publishing this presence, others could quickly ascertain a MyState user's whereabouts. Typically, on the weekends, many participants would leave the university for a couple of days and could quickly publish this information to the group as they left. As another example, some participants who would frequently go running would record the start and end time of their run using two tags. Though this can obviously be performed by other means, the convenience of having the phone at hand and the simplicity of recording the time via a single touch without leaving an application running led to this adoption of MyState.

Many of the posts sent to MyState were sent in order to organize the activities of the flat mates in Study B. In the flat where the participants lived, there were many shared facilities in the bathrooms and kitchen. MyState posts were sent in order to synchronize these shared facilities, such as the showers, sink or cooker. Also, many of these activities required two tags: one tag to signal that an object is in use and another to signal that the object is no longer in use. For example, one post "Gone to lectures" and another "Back from lectures". Social associations were also suffixed to the activity posts, such as groan, ☺, ☹, yawn, bored, happy, and excited. For example, "Doing work ☹". This provided the post audience with an insight into what the activity means to the user – an important piece of information that is lost by automated context gathers, such as GPS location trackers.

There were many cases when users would view MyState posts in order to retrace their post history. This may be to relocate lost objects (e.g. set of keys) by gaining a better insight into what they were doing at the time. This may include the locations they were during the day or activities carried out which may indicate that, for example, a set of keys might be in another set of clothes.

Other uses were to check previous activities. For example, checking how many lectures they had attended over a period of time as they would post when they went to a lecture. Here we see that the repetitive posts from MyState serve the purpose of providing the user with an indication of the frequency activities were carried out. With Study B, there were cases when these more personal uses had also a social perspective (i.e. other MyState users could identify forgotten objects or tasks on the user's behalf). For example, one participant had to take three antibiotic pills a day during the course of the study. To help remembering, the person placed a tag on the box of pills so that each time taking a pill, the person would read the tag. In addition, because the flat mates were aware of this, they could check the MyState posts and potentially identify when a pill had not been taken that day. Here, we see again a case where the number of identical posts serves as a valuable component to the user.

Another use was to claim personal or shared tasks. An example from the study came from particular users indicating that they were cleaning the kitchen and washing dishes. These are repetitive tasks that coincide well with the reusable nature of MyState posts. As MyState identified the person who reads the tag, it was seen as a good way of tracking who had done their fair share with respect to the household chores. Here, we see that the frequency of posts serves as a perfect way to tally the tasks carried out by each participant. A user with a high frequency of these posts could also be used as an indirect way to request help from others.

Social Usage

Participants would frequently update their state regarding their willingness to socialize. Typical examples are posting whether they were asleep, awake or working. From these posts, others can avoid disturbing through neighbouring noise or visits. In contrast, there were also examples where participants would encourage others to join them in socializing. Tags were placed in shared areas, such as the kitchen, which would request others to join them. Also, there were many ways to implicitly encourage socializing by posting a message with an activity normally involving multiple people and a location where it is taking place. For example, a multiplayer Xbox game in a participant's room. Further examples include posting a message that indicates that people are on their way to a particular bar and others are welcome to join.

A hide-and-seek tag was created by the participants in Study B: a tag was hidden with a post "found the hide and seek tag" written to it. Once the tag was in place, a message was directly sent from the phone to begin the game. Other entertainment uses included a tag that posted "activated the silent alarm", and placing a blank tag in a public space with a reward for the first person to write to it – "Just put a tag outside spa, first one to tag it gets a prize!."

Another example of fun included replacing the data on a tag that was shared by all (a tag on the exit door to the building). This tag was rewritten from a message stating they are leaving the building to a message that stated that one specific music band was better than the other (a point of debate beforehand). To counter this, the message was changed again; this time, in favour of the other band before returning back to the original message. It raises an important point about message overwriting and the decoupling of the physical label written on the tag and the contents of the tag. Though rewriting could have been prevented in the implementation of the phone client, we wanted to allow overwriting in order to observe behaviour such as this.

MyState was also used to warn others about particular recurring events. Such examples include when students had drunk too much alcohol (a fairly regular occurrence) and would render the bathroom facilities unusable. The unfortunate person to identify this could alert the others who share these facilities. Though crude, this usage can be an example of the more general use of alerting others.

There were also many occasions where participants' feelings about one another could be broadcasted to the group. Many of these were based on the characteristics of certain users; for example, a tag was made for a user who was renowned for clumsiness. This would be read when this person had broken something again in a particular room. Here, we see MyState describing the association between multiple people rather than the association between a specific tagged object and its user. In these cases, the location of the tag to an object may not be so important, though the general position of the tag should correspond to where the interactions occur or have previously occurred.

We found participants using MyState in order to provide them with a sense of identity in group. This was particularly true for the Study A group where the sense of identity did not currently exist due to their unfamiliarity with one another. Here, users could use MyState to find out more about each other. Examples of this are tagged DVD cases, books, and music the titles of which could be posted when watched, read or listened to. Obviously, videos were uncommon due to the low level of repetition in watching the same film; however, the time to read a book can be fragmented into several periods and music can have a high level of listening repetition. However, identity is only really provided at the first post, consequent posts may serve to convey more functional meanings, such as "I'm busy". Certain activities, such as "I'm playing the guitar" also provided a participant with a sense of identity.

We also saw posts from objects that had a symbolic meaning to the user rather than utility. For example, a political poster in one of the participant's rooms was associated to a particular post. Another example is a plant that had been tagged with a message "meditating the zen way" as people associated this plant to their meditation routine.

What types of posts were most common and how did these differ between the study groups?

From both studies, we categorized the types of posts sent. During categorization, various assumptions were made and consistently adhered to. Primarily, the *non-work activities* are exclusive of any of the other groups. Therefore, "I'm travelling" would be classed as *transit* only. If the message was "I'm travelling to Leeds" this would be classed as *transit* and *location*. *Presence* was considered as a user's availability to socialize rather than location, and *Social* was considered as expressing a miscellaneous social message, such as "It's a nice day outside." *Notifications* are considered as broadcasts about a particular event or situation in order to notify others, for example, "the kitchen floor is wet." In Figure 14, we can see the percentage of posts associated to each category for both studies. What is interesting is how these change based on the different groups of participants.

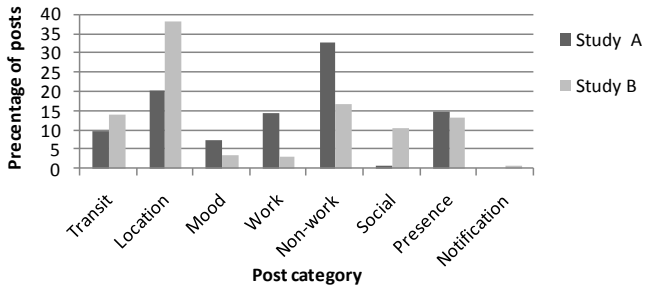

Figure 14. Percentage denoting the popularity of each type of MyState post from both studies.

In Study A, we see a large percentage of posts in the *non-work activities* category. Here, the participants are able to learn more about one another and find common interests. In doing so, participants begin to establish closer bonds simply by allowing others an insight into their daily lives. We also see a greater percentage of work-related posts than in the Study B group about when they work and what they are working on. This fact is also reflected when we observed the times of posts. We found the interval between 12pm and 4pm to be the most frequent post period as this group contained students of the same course and they find a common ground here. Within Study B results, we see much more activity synchronization by letting others know where they are (shown by *location*). We also see much more *social* postings about options they have about certain topics or about each another. Again, when observing the most active time period for Study B group posts, these were the more social hours between 4pm and 8pm.

Conclusion and Future Work

In this work, we presented MyState, a novel concept that enables users to create personalized physical interfaces that can be used to share information with the social community through quick, explicit touch interactions whilst providing complete control over when this information is shared. As a counterpart to the MyState prototype, we conducted two field studies that lasted several weeks that focused on appropriation. From both studies, we observed both personal use, such as retracing steps and activity history, and social use, such as synchronizing activities, expressing moods, games, and tracking shared items. We also explored how these uses vary based on the type of group and their social bonds. In particular, trends in Study B are tag sharing and location awareness, whereas, with Study B, there is greater emphasis on using MyState to convey interests and experiences to others in order to form social bonds. In addition, we found that tags were attached to many different types of objects varying in mobility and ownership. Furthermore, we showed (through Study B) that most users chose to continue using the prototype when no incentive was provided. As we explore the solution within the confines of the study environment, we have seen primarily routine behaviour from participants. Outside of this environment, particularly in public areas, it would be interesting to explore the levels of tag sharing and the degree of tag reuse it supports due outside of user's routine.

Based on lessons learnt from this work, we will focus future work on providing custom friend groups in MyState that map to various different uses of MyState. We will also push towards linking various media captured by the phone to the tags and investigate the concept of locking mechanisms for both public and private usage of MyState tags. Furthermore we will assume that we see more frequent use of MyState by the participants of our upcoming studies when using NFC smartphones which are available in the meantime such as the Google Nexus S.

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